Engineering Education in the Next Millennium in India

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Introduction

Engineering Education in developing Countries (More so in India) is neither able to meet the varied and changing Industrial demands nor socially relevant and productive. The Industrial needs are many and varied. The local, national and global needs are rapidly changing. The Industry complains that Engineering Graduates are not readily employable, but need further Training. There is mismatch between the knowledge, curriculum and skills imparted by Technical Institutions and Industrial needs. Universities are not able to inspire the Industries to come to the academic platform and, make use of their expertise in structuring Engineering Education.

Little attention is being paid by universities for the ever growing and diverse social needs. The fruits of Technology are not reaching the downtrodden and under previlized in the society. Taking these points into consideration a model is developed for a more useful productive and socially relevant Engineering Education System.

1. India - some social indicators

India is a country with 25 states, 14 major languages and different Socio-economic and cultural backgrounds. Indian social structure is unique, blend of diverse religious, culture and racial groups. The uniqueness of Indian social structure lies in its unity in diversity.

Total Population	:	97.8 millions
Area	:	3287263 Sq. km
Urban population	:	27%
Rural population	:	73%
Literacy	:	52.11%
Female literacy	:	36%
Population without access to health services	:	135.2 millions
Population without access to safe drinking water	:	171.3 millions
People without access to sanitation	:	640 millions
Universities	:	226

2. Technical Education in India

India has 700 Engineering Colleges admitting more than 0.15 million students annually. Their locations however do not follow any Geographical pattern (68% of the colleges are located in the four States of Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra). There are 7 Institutes of Technologies (IITs). These are the Institutes of excellence and 17 Regional Engineering Colleges (REC) followed by University Engineering Colleges, Government engineering colleges and Self Financed Engineering Colleges.

Status of Engineering Education and Technical Institutions in India are shown in Annexure - 1.

3. The present curriculum structure in India

Curriculum is not planned either to the Industrial demands or needs of society. The following subjects are covered.

Basic sciences	:	10.8%
Engineering sciences	:	17.2%
Technical Arts	:	20.1%
Applied and Design Engineering	:	43.8%
Miscellaneous subjects	:	8.1%
Total	:	100.0%

4. The structure of engineering curriculum in USA

Most of the good Universities in USA design their curriculum keeping in mind Technological changes, Industrial demands and to social needs. The subjects covered are as follows.

Basic sciences	:	25.0%
Engineering sciences	:	25.0%
Technical Arts	:	2.8%
Applied and Design Engineering	:	22.2%
Humanities and Social Sciences	:	22.2%
Thesis	:	2.8%

5. Structure

A comparison of the structures reveals and shows striking differences. The first difference is in the coverage of basic sciences. The percentage is lower in India. The second difference is the time spent in technical arts. In USA no time is allotted to Workshop, drawing and Computer Programming. The probable reason for this is that most students in USA who opt for engineering have done some Workshop practice and Computer Programming at the high school level. Drawing is not considered to be an essential subject any more presumably because of the availability of many software packages for drafting and drawing. The third difference is that in India considerable time is spent on Applied and Design Engineering subjects in which a fair amount of empirical information is included. This is not considered essential in USA. Instead they find it more profitable, to spend nearly 20% of the time in the teaching subjects in Humanities and Social Sciences. Excepting for some exposure to economics, these do not find a place in the Indian curriculum.

Apart from the differences in structures, two important factors differentiating the U.S. curriculum from Indian curriculum are in the nature of the flexibility offered and the innovativeness inherent in project type laboratories. The flexibility enables to cater to the needs of different categories of students those who will base their professional careers as engineers on the Bachelor's degree with no further formal study; those who will proceed further for post graduate studies in engineering or an allied field, and those for whom the under-graduate programme provides a broad base for further professional study in fields like management.

The use of open-ended project type laboratories instead of set laboratory experiments greatly enhances the learning process.

6. Flexibility of approach

University Industry Partnership was (Industry Institute Interaction I.I.T.) discussed several times on various platforms, seminars, symposia, workshops and conferences, but the distance between institutions and industry could be reduced, if at all, only marginally. The main reason for this, is the rigidity in the educational system. The institutions are governed by the State Governments and academically by the universities and there is no mechanism to watch and ascertain the changing demands of man power required by the industry. Even to make a small change in syllabus, it takes more than a year to go through the process of Boards of Studies, Faculty and the Academic Councils of the University, introducing new courses is almost out of question. What is required is autonomous Institutions and institutions willing to run need based courses on requisition. There are enough of colleges some of which may be centres of excellence, but these run stereo-typed, Diploma, Graduate and Postgraduate Courses. New institutions must emerge who can cater to the changing demands of the industry. Industry has to pay for this Educational and training services.

7. The Role of Employers

For quite sometime employers in India have mostly recruited graduates of government funded universities. Now as there is more freedom allowed for private enterprises there is greater choice to industries in manpower selection. Industries can also take part in technical training.

The ultimate survival of any industry is its productivity for which technological excellence is a must. Good training and goal setting programmes have a far greater impact on productivity.

8. Some suggestions for Improvement

⇒ There is a need for reducing the number of subjects taught in a semester to five or six, and the contact hours of instruction to a maximum 30 per week. The reduction in contact hours implies that the student is expected to do more work on his own in the form of self-study and assignment.

⇒ More flexibility is to be provided in the form of elective subjects so that the curriculum caters to the local and regional needs.

⇒ Hands on experience should be conveyed through open-ended project type laboratories.

⇒ The emphasis on some of the technical arts, particularly drawing and workshop practice, could be reduced.

⇒ The coverage of basic sciences should be improved.

⇒ The possibility of introducing some subjects in the Humanities and Social Sciences should be seriously examined. Subjects in Psychology, Sociology and Economics as applied to industry are of particular relevance in the Indian context. Subjects which covers Social needs, legal aspects in technology, patent laws, aspects of international trade and commerce, history of science and technology, etc. should be introduced.

The Model :-

Taking into accounts the above patterns and trends in Engineering Education, a model is developed to suit the social and industrial needs (Annexures 2,3,4). A systematic appraisal of academic programs and socio-economic and Industrial needs should be under taken by comprehension data collection for general and specific needs and with constant upgradetion and projections. This work can be entrusted to students as part of their project work. User and beneficiary participation (by way of workshops, short term courses, seminars, conference conducted by University and Industry) will bring scientific approach for curriculum design, training and retraining for the work force. Keeping the Core and Basic science component as common, Electives can be offered to meet the local and regional needs. This also provides necessary flexibility and to change the Electives when the needs are fulfilled. The Model presented represents the various (Interactions and participation) between society, Industry and University for developing a socially relevant and Industrial useful Technical education.

Traditionally Indian Society is slow in adoption and resists changes and so continues feedback and exchange of views are necessary.

9. Conclusion

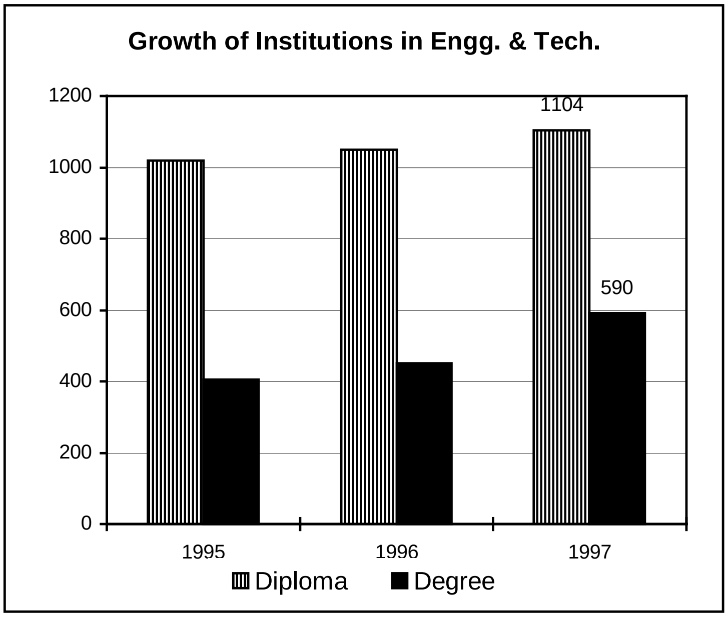
* The curriculum in Engineering Education must be flexible to suit the contemporary needs of Industry and Society and scope for Vertical and Horizontal mobility.

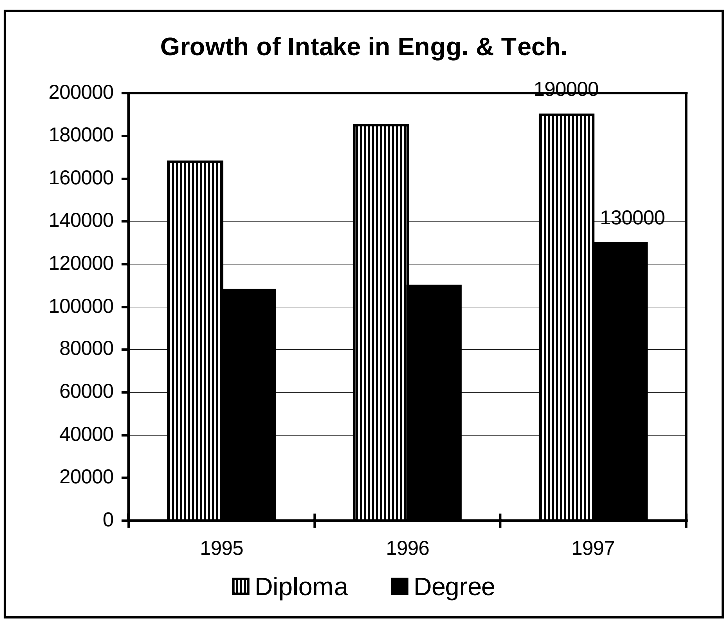
* Minimum response time for changing the curriculum based on Industrial demands and needs of Society.

Acknowledgments

The author thanks Prof. V.C. Kulandaiswamy, Prof. R. Natrajan, Prof. S.P. Sukhamte, Prof. Ramanujam and Prof. N.V. Ratnalikar for making use of some of their material and ideas in preparing the paper.

ANNEXURE 1


Growth of Institutions in Engg. & Tech.
1200
1000
800
600
400
200
0
1104
590
1995
1996
1997
Diploma
Degree


Growth of Intake in Engg. & Tech.
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
190000
130000
1995
1996
1997
Diploma
Degree

Actual and Estimated Growth of Engineering Institutions at Degree Level

Year	No. of Institutions	Intake Capacity	Out turn of graduates
1947	46	320	270
1950	58	778	2021
1970	163	18207	82232
1990	339	87221	414654
1997	600	110000	61680
2000	580	128000	715524
2005	740	148000	91377
2010	944	188000	110000
2015	1205	241000	150000
2020	1600	310000	190000
2025	2000	400000	250000

Out turn of Engineering graduates in various disciplines in the years 1991-1997

Discipline	1991	1992	1993	1994	1995	1996	1997
Chemical	1928	1796	1928	3213	3213	3213	3283
Civil	8514	8147	8514	8127	8127	8163	8163
Computer	7011	7304	7600	9106	9127	9227	9519
Electrical	5399	3716	5399	7108	7108	7192	7430
Electronics	6746	7322	11269	11405	11561	11893	11884
Instrument	863	845	863	2388	2478	2567	2733
Production	1112	1030	1122	3522	3522	3544	3589
Mechanical	9527	9538	9850	12415	12457	12605	12880
Mining	348	536	536	402	402	402	403
Metallurgy	497	469	497	489	489	489	489
Textile	459	414	459	626	626	626	658
Misc.	829	829	829	829	829	829	829
Total	42963	41946	44909	59494	59853	60419	61860

Out turn of Engineering graduates in various disciplines in the years 1998-2005

Discipline	1998	1999	2000	2001	2002	2003	2004	2005
Chemical	3465	3808	3864	4285	4523	4762	5001	5240
Civil	8163	8223	8223	8113	8091	8068	8046	8023
Computer	10119	11094	11939	11716	12186	12656	13126	13596
Electrical	7906	8704	8746	9492	9968	10445	10921	11398
Electronics	14450	15560	15635	17161	18223	19286	20349	21411
Instrument	3033	3078	3078	3777	4066	4354	4642	4930
Production	3634	3754	3754	4713	5051	5388	5726	6063
Mechanical	13512	14768	14553	15558	16177	16795	17414	18033
Mining	402	420	420	399	394	389	384	379
Metallurgy	489	489	489	490	490	490	490	490
Textile	668	722	758	800	836	872	908	944
Misc.	829	865	865	855	859	862	866	869
Total	66670	71195	71524	77359	80863	84368	87873	91377

Stock of Engineering graduates in various disciplines in the years 1990-1997

Discipline	1991	1992	1993	1994	1995	1996	1997
Chemical	33268	35064	36992	40205	43418	46631	49914
Civil	128454	136601	145115	153242	161369	169532	177695
Computer	16511	23815	31415	40521	49718	58945	68464
Electrical	92429	96145	101544	108642	115760	122952	130382
Electronics	48576	55898	63220	74489	85894	97455	109348
Instrument	3543	4388	5251	7639	10117	12685	15418
Production	5972	7002	8114	11636	15158	18702	22219
Mechanical	140457	149995	159845	172260	184717	197322	210202
Mining	4838	5374	5910	6312	6714	7116	7518
Metallurgy	13617	14086	14583	15072	15561	16050	16539
Textile	8389	8803	9262	9888	10514	11040	11790
Misc.	829	1658	2487	3316	4145	4974	5803
Total	496883	538829	538738	643232	703085	763504	825364

Stock of Engineering graduates in various disciplines in the years 1998-2005

Discipline	1999	2000	2001	2002	2003	2004	2005
Chemical	57187	6100551	65336	69859	74621	79662	84862
Civil	194081	202304	210417	218508	226576	234622	242646
Computer	89677	100816	112532	124719	137375	150502	160498
Electrical	146992	155738	165230	175198	185642	196563	207961
Electronics	139358	154993	172154	190377	209663	230012	251423
Instrument	21529	24607	28384	32450	36804	41445	46375
Production	29679	33433	38146	43197	48585	54311	60374
Mechanical	238192	252745	268303	283379	301275	318689	336721
Mining	8340	8760	9159	9553	9942	10326	10705
Metallurgy	17517	18006	18496	18985	19475	19965	20455
Textile	13180	13938	14738	15573	16445	17353	18297
Misc.	7497	8362	9217	10076	10939	11805	12674
Total	963229	1034753	1112112	1192975	1277343	1365215	1456592

Stock of Scientific & Technical Persons in India 1950-1996 (No. in Lacks)

	1950	1960	1970	1980	1990	1996
Engg. & Technology (Degree and Diploma)	0.53	1.37	4.3	5.51	11.90	20.2
Science, Natural Science, Medicine & Agriculture	1.4	3.13	7.45	12.14	26.20	44.48
Total	1.93	4.5	11.75	17.65	38.10	66.7

Expected Stock of Scientific & Technical Persons in India 2000-2025 (No. in Lacks)

	2000	2005	2010	2015	2020	2025
Engg. & Technology (Degree and Diploma)	26.91	37.52	50.43	65.25	86.5	109.4
Science, Natural Science, Medicine & Agriculture	59.2	82.54	117.64	150.1	198.95	262.7
Total	86.11	120.06	168.07	215.35	285.45	372.1

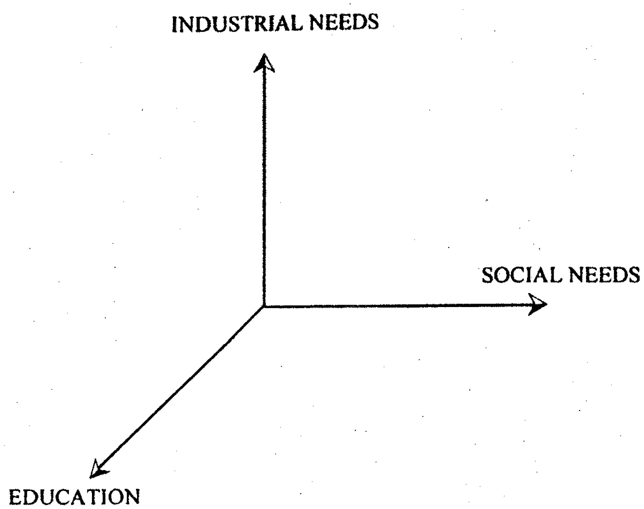
Expected Stock of Scientific & Technical Persons per Thousand Population India in years 1991-2025

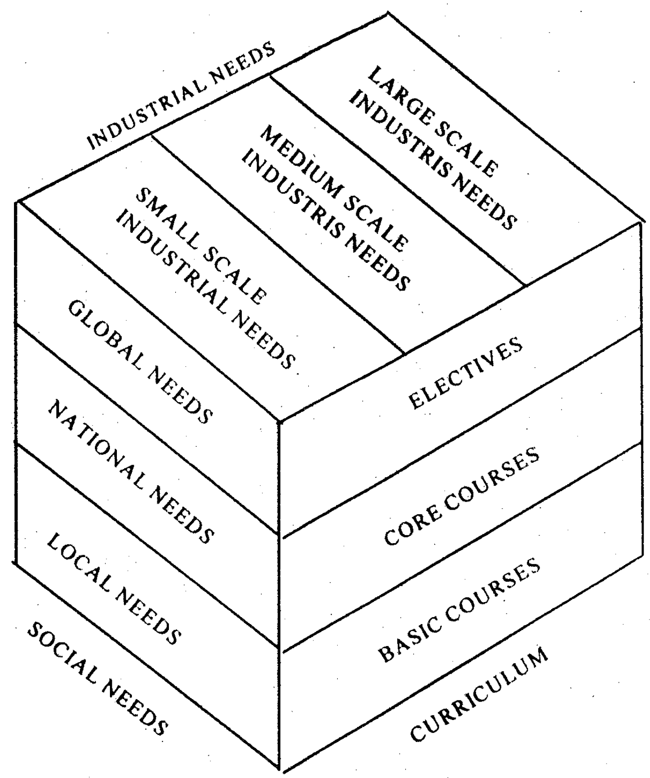
Year	Population in Million	S & T Personnel in Million	S & T Personnel per thousand population
1991	838	4.85	5.77
1997	970	6.67	6.87
2000	1000	8.61	8.61
2005	1100	12.00	10.90
2010	1180	61.8	14.24
2015	1250	21.54	17.23
2020	1320	28.5	21.62
2025	1380	37.21	26.96

Stock of Scientific & Technical Persons per Thousand Population for selected Countries in the World (1990)

S. No.	Country	Stock	S. No.	Country	Stock	S. No.	Country	Stock
1.	Canada	18.6	10.	Israel	82.5	19.	USA	21.1
2.	USSR	139.2	11.	Australia	53.6	20.	Cuba	14.4
3.	Sweden	113.6	12.	Korea	53.1	21.	Brazil	11.2
4.	Japan	112.8	13.	Hungary	50.00	22.	China	8.4
5.	Venezuela	107.8	14.	Spain	45	23.	Pakistan	4.1
6.	Denmark	97.8	15.	Philippines	36.6	24.	India	3.8
7.	UK	89.5	16.	Argentina	34.8	25.	Indonesia	3.5
8.	Germany	85.1	17.	Singapore	26.6	26.	Nigeria	1.4
9.	Italy	83.1	18.	Austria	21.6	27.	Guyana	1.3

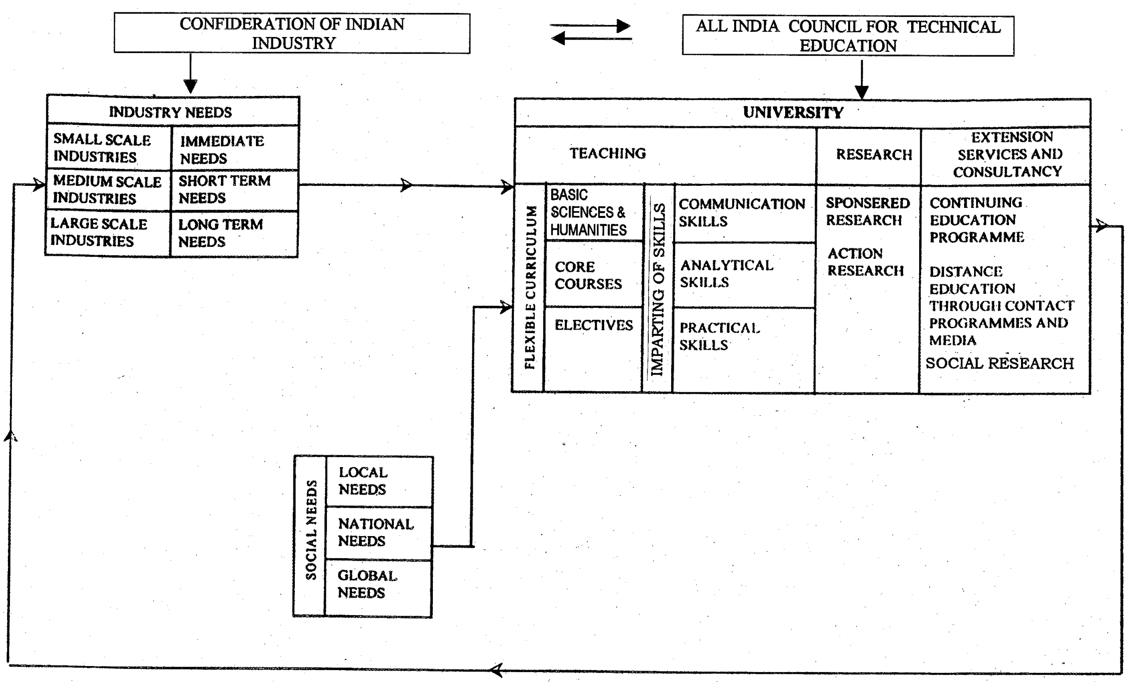
ENGINEERING EDUCATION IN THE NEXT MILLENNIUM IN INDIA





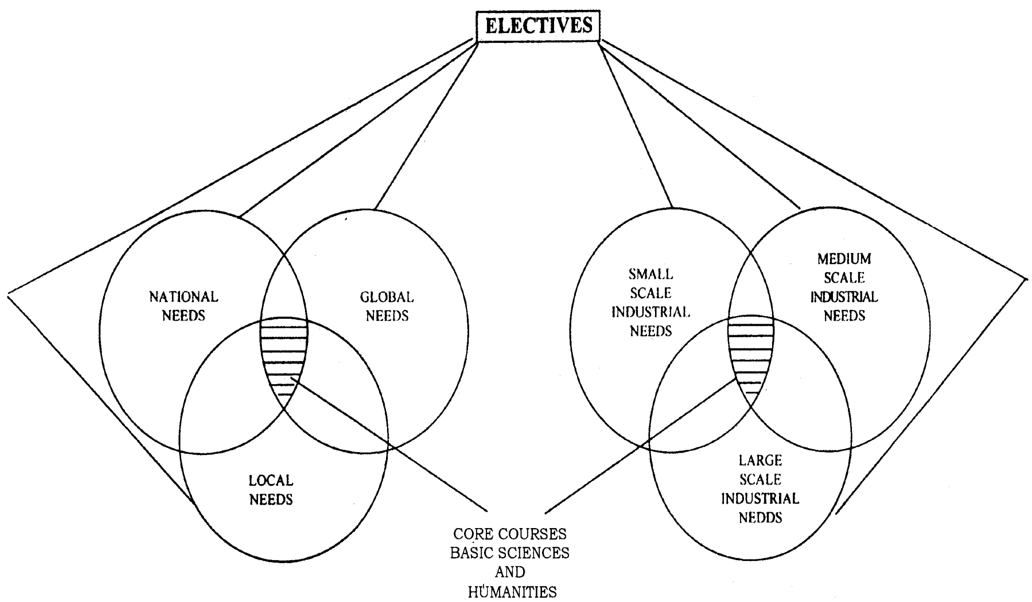
ANNEXURE 2

ENGINEERING EDUCATION IN THE NEXT MILLENNIUM IN INDIA



ANNEXURE 3

ENGINEERING EDUCATION IN THE NEXT MILLENNIUM IN INDIA



ANNEXURE 4